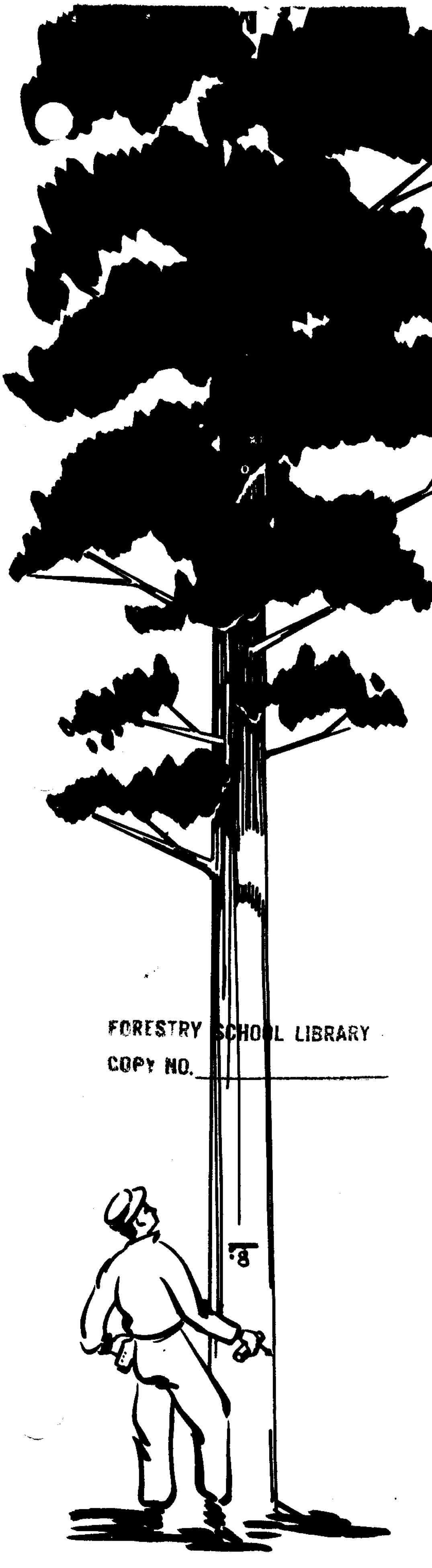

FOREST CONTROL by CONTINUOUS INVENTORY

"Today I have grown taller from walking with the trees."
...Karle Wilson

Milwaukee, Wis. October, 1960 No. 79

ACCURACY AND THE BASIC DATA FOR FOREST MANAGEMENT

"---- The other requirement of the management inventory is that it should be capable of measuring the changes that occur in forest conditions on the area. This is probably one of the most important requisites of an inventory system since sustained yield management is hardly possible without periodic readjustment and revision of data to fit the changing conditions of the forest. That is why the ordinary one shot timber cruise, which pictures the forest in a static condition, falls short of the requirements of a management inventory. The final requisite is that the inventory system must lend itself to a very high degree of accuracy. I am sure that most of those who have had any experience with plot measurements in the forest have been appalled at the inaccuracies that invariably creep into the collected data. Such inaccuracies often go unnoticed until, to your consternation, such things as decrement appear in remeasured immature stands and the confidence in all of the data is seriously shaken. I do not hesitate to state my conviction that many of the volume and yield tables that each of us is presently using contain certain inaccuracies that we would consider unacceptable if we were aware of their existence. If we are going to develop growth and yield tables as a basis for intensive management, then too much thought and planning cannot go into them to see that they are as accurate as we can make them."

Reprinted from "Continuous Forest Inventory and its Relation to Forest Management at North Western Pulp and Power Ltd."

by

D. I. Crossley

FOREST SERVICE U S DEPARTMENT OF AGRICULTURE

The Forester

PART II

TREE RECORDS ARE ONLY AS GOOD AS THE TECHNIQUES USED IN MAKING THEM

Errors of Judgment in Plot Area Classification

Silvical, administrative, economic and operational classifications of the area within the permanent sample plot are based on common field judgment guided by written class standards or limits. Now, we must expect that class lines will have frayed edges when their basis is human judgment, and this is exactly what happens. There is nothing wrong with these approximations when they are thoughtfully made. There is even some advantage of slight overlap in such criteria as stand density and size class. When we build stock and stand tables from these kinds of data, we know that they are as realistic as our ocular judgment of the forest can ever be. Our woods judgments cannot delineate exact class lines, and so our tabulations need not bother to secure this unreal refinement. Obvious errors, however, should be corrected for they affect both the area and volume answers in proportionate sampling.

Errors of Theory and Technique in the Use of the Diameter Tape

Repeating identical individual tree records introduces the necessity for precision in diameter measurement. This need is not readily accepted by cruisers.

In the first place they are reluctant to admit that there is such a thing as a standard technique for the use of the tape. They seldom realize that periodic variations in tape technique between different men are very apt to introduce consistent errors of measurement, or that each of the four different diameter tapes on the market gives different results.

There are those who believe that because tenth-inch errors are small they will compensate. Instead, personal errors of this kind never tend to balance out, but consistently veer in one direction.

Still other cruisers carry in the backs of their minds the thought that since the trees will ultimately be grouped into one-inch diameter classes, the tenth-inch they measure and record is an unnecessary refinement. They fail to realize that checks on the plot work will be made to tenth-inch diameter intervals, that a tenth-inch is about a full year's growth in the north central region, and that the volume table for computing has a 1/10" diameter interval.

Some cruisers, knowing that no tree lends itself to exact measurement, assume that there is no particular need for fine precision. Knowing how difficult it is to be free of sin, they throw all caution to the winds. The flaw in this philosophy is obvious.

There is need for intensification of training in the use of the diameter tape, both on the job and in the forest schools. Measurement intervals of one-tenth inch in DBH are not too fine for the CFI system in the pulp timber regions.

Errors and Problems in Deducting For Cull in Trees

The northern sawlog and pulpwood forests are full of disease and rot. This is a problem of serious import to the forester who must gradually remove this material from the woods, and to the cruiser who must learn to deduct this waste from the gross scale of sawlog and pulpwood trees.

Cull deduction is handled with greater accuracy today than 10 years ago. It is done in the woods by an individual tree assessment of damage, rather than by the application of broad cull factors or net volume tables to the final answers. The success of the method depends upon the cruiser's ability to identify the disease, diagnose its extent and make the proper deduction to sound scale.

Perhaps the greatest problem in cull determination is the cruiser's failure to observe accurately.

Identification also is important. Foresters in the north central region should know at a glance the two or three dozen serious pathological and physical causes of wood loss in standing trees, and they must learn not to deduct for inoccuous and imaginary things. It is necessary to know the appearance of early and late stages of deductible defects and their variations due to species, age and site quality differences.

Following this, the problems of determining the extent of the defect in the tree and the correct assessment of cull percentages are important. These decisions are helpfully guided by cull deduction standards and charts originating in the Lake States Forest Experiment Station and modified slightly for practical field use.

The Problem of Determining Tree Lengths

One of the chief sources of error in past inventories has been the decisions on the usable lengths of trees. It has been the custom to use ocular judgment supplemented by hypsometer measurements, but neither of these techniques is sound enough for the permanent plot work of the CFI system.

In recent years the tree length problem has been materially reduced by the use of the old European trick of measuring with poles. Another helpful guide has been the regional taper table reduced to pocket size for field convenience. When we add to these the concept of slow, careful work, with stronger emphasis on measured checks, we have the best techniques now available for taking tree lengths.

Using these guides and procedures, the CFI cruiser records the length of every tree, in every plot, at each remeasurement period. There is no measurement of random sample trees within the plot, and therefore no application of averages from these samples to the remaining unmeasured trees.

Each tree is measured, and each tree bears a close, direct relationship to the soil on which it grows. There is no leveling of volume or growth over the many area separations of the whole forest. Each area breakdown stands firmly on its own feet, and comparative, tested results are significant.

The most economic measuring tool thus far seems to be a cheap, flexible, 20-foot, unjointed bamboo pole, banded at two-foot intervals, and sometimes with a hook or diameter gauge taped to the top. Pulled through the woods like a chain, it weaves and twists among the trees and causes very little travel difficulty.

Measuring poles, taper guides, training and checking do not completely eliminate length errors, because an element of judgment is still involved. It is necessary for the cruiser to estimate the point of minimum diameter, and on tall trees he must judge the distance between the top of his measuring pole and the top utilization point of the tree. There can be both careless and consistent mistakes in these two tasks, but most of these errors are caught and corrected at the time of the repeat measurement.

It is a great convenience to know, at the second measurement, that the first length was pole measured. This is a starting point for fresh and improved judgments of the new lengths and of corrections for the old lengths if changes are necessary. Fully two-thirds of the trees in the north central states can be directly pole measured since their usable lengths are less than 26 feet.

Problems in the Practice of Grading the Wood Quality of Standing Trees

Log and tree grading systems for the determination of wood quality are increasing in use. Valuation inventories are not feasible without them, and the profitable management of sawlog forests is directly dependent upon a sound knowledge of log and tree quality grades.

The Forest Products Laboratory log grading standards offer the most accurate measure of hardwood sawlog quality. The rules are definite in their differentiation of 4 log quality classes, and once learned, they are simple, concise, and easily applied. These rules are excellent for repeat measurements. They have turned out sound and comparable records on growth by grade, but like all rules and guides, they must be used with care and understanding. The clear faces must be precisely measured, and the defects clearly observed and expertly identified. Flash grading for quality is not good enough for tree by tree comparisons between inventories.

The greatest failing in tree quality grading is caused by hasty work, with its oversight of defects and their position on the trunk. The top diameters of the log being graded cannot be ascertained exactly, the butt-off section is not a definite, but a judged deduction, and the ends of the logs are not visible. Some error is introduced because of these factors.

It is common practice in the north central region to grade the quality of a butt segment of trees to show the trend or indication of the total log grade recovery in the stand. Few projects grade all of the logs in the trees, and this does not seem necessary since more than half of the volume of hardwood sawlog trees is found in the butt log.

Many companies now grade pulpwood as well as sawlogs. The pulpwood quality rules offer simple flash grading standards, the chief purpose of which is to separate out the trees with poor, dirty, rotted wood. Only two woods grades are recognized and generally less than 5% to 10% of the wood in the northern forest is of the lower grade.

Errors and Problems in Tree Vigor Grading

The application of data processing methods and the unit record system encourage the health or vigor grading of individual trees in the CFI system. Incorporated into the inventory work of the Forest Service 20 years ago, tree vigor grading is now a commonly accepted guide to the silvical condition of the forest. Vigor grading has encouraged and improved timber marking; it has favorably altered cutting progression, and if carried on with unflinching persistence, it will some day result in a wholesale improvement of silvicultural practices. The constant reiteration of tree vigor judgment on hundreds of thousands of trees by hundreds of cruisers, has given them an insight into tree condition and the nature of the forest which they will never forget.

Tree vigor classification is a flash grading process. The cruiser separates the trees into realistic groups of good, fair, poor and cull growing stock. These classes bear a direct correlation to the cutting time for the stands.

We may expect in flash grading tree vigor, that three-fourths of the trees will be placed in their proper classes by all cruisers, but that there will be disagreements on the remaining 25%. Most cruisers become proficient tree graders after a few days of intensive training, but they become careless later and require follow-up supervision and check.

Only relative accuracy is required in tree vigor grading, but to assure this, certain basic precepts are important. Tree vigor grading rules are common to all species. No matter how inferior a particular species may be, it is never graded down because of this fact, but only because of its condition. There are limiting factors which establish tree vigor without a detailed examination of the tree. Extreme rot, or canker, severe suppression, unusually small or poor crowns or high risk are examples of factors limiting tree vigor to the lowest commercial classification.

The points for diagnostic observation in tree vigor grading include crown class, crown size, leaf density or condition, bole form, rot and risk. If these qualifications are checked from two sides of the tree and at a reasonable distance from it, consistent and satisfactory accuracy will result.

CAL STOTT,
Forester
U. S. Forest Service, Region 9

STATISTICAL PROCEDURE LEAFLET #9

CALCULATING THE LIMIT OF ERROR IN AREA AND VOLUME COMBINED

Since there is a limit of error for both the estimated average volume and the estimated area, when we multiply the two to get the total volume on any particular breakdown we shall wish to calculate the limit of error for the product. The limit of error for this product is very easily calculated by adding data used to calculate the individual limits of error in volume and area as shown below.

Formulae for limits of error 1/:

In VOLUME

$$Ev = \pm 2\sqrt{\frac{B}{Na - 1}}$$

In AREA

$$Ea = \pm 2\sqrt{\frac{N - Na}{N \times Na}}$$

In combined AREA x VOLUME

$$Eva = \pm 2\sqrt{\frac{B}{Na - 1} + \frac{N - Na}{N \times Na}}$$

WHERE:

Ev	=	limit of error in volume
Ea	=	limit of error in area
Eva	=	limit of error in combined area and volume
N	=	total number of plots on whole forest
Na	=	number of plots in an area breakdown
ΣX	=	sum of individual plot volumes
ΣX^2	=	sum of squares of individual plot volumes
$(\Sigma X)^2$	=	square of the sum of individual plot volumes

$$B = \frac{Na\ (\Sigma X^2)}{(\Sigma X)^2} - 1$$

For EXAMPLE when:

N = 661 plots; ΣX^2 = 93.081

Na = 31 plots; $(\Sigma X)^2$ = 1594.002

$$B = \frac{31\ (93.081)}{1594.002} - 1, \text{ or } .810$$

Limit of error-VOLUME

$$Ev = \pm 2\sqrt{\frac{.810}{31-1}}$$

$$= \pm 2\sqrt{\frac{.810}{30}}$$

$$= \pm 2\sqrt{.027000}$$

$$= \pm 2\ (.164)$$

$$= \pm .328, \text{ or } \pm 33\%$$

Limit of error-AREA

$$Ea = \pm 2\sqrt{\frac{661-31}{661 \times 31}}$$

$$= \pm 2\sqrt{\frac{630}{20491}}$$

$$= \pm 2\sqrt{.030745}$$

$$= \pm 2\ (.175)$$

$$= \pm .350, \text{ or } \pm 35\%$$

Limit of error-AREA x VOLUME

$$Eva = \pm 2\sqrt{\frac{.810}{31-1} + \frac{661-31}{661 \times 31}}$$

$$= \pm 2\sqrt{\frac{.810}{30} + \frac{630}{20491}}$$

$$= \pm 2\sqrt{.057745}$$

$$= \pm 2\ (.240)$$

$$= \pm .480, \text{ or } \pm 48\%$$

1/ The 2 in each formula is approximate "t" factor for 95% probability. See Statistical Procedures Leaflet #4 for discussion of probability.

WILLIAM WARREN BARTON, Forester, U.S. Forest Service, Region 7